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PROJECT ECONOMICS FOR WOOD ENERGY

Penn State **Extension**

Common forms of biomass

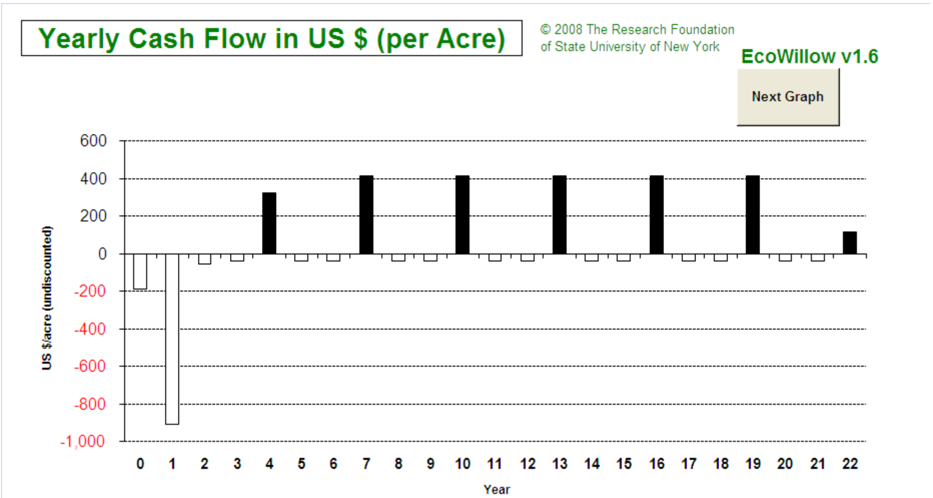
Generally material derived from any animal or plant

- Forestry residues and co-products
- Other clean woody material – joinery waste and arboriculture waste
- Agricultural by-products, e.g. straw
- Energy crops – Short Rotation Coppice (SRC), e.g., willow, miscanthus,

Common fuels and their relative costs

Fuel and Price	Typical Delivered Price	Fuel Heating Value (HHV)	Typical Combustor Efficiency (%)	Cost per Unit Energy ($/GJ)
Cordwood, 30% moisture, Delivered	$150 per cord	14.1 MJ/kg	60	13.36
Clean, Green Wood Chips, 40% moisture	$50 per ton	12.1 MJ/kg	80	5.73
Dried Wood Chips, 20% moisture,	$70 per ton	16.1 MJ/kg	80	5.72
Premium Hardwood Pellets, 5%	$6 per 22 kg bag	18.1 MJ/kg	80	18.83
Switchgrass Pellets, 5% moisture,	$6 per 22kg bag	17.2 MJ/kg	80	19.82
Natural Gas	$12 per 1000 cf	38.3 MJ/m3	80	15.35
Fuel Oil	$3.50 per gallon	36.4 MJ/litre	80	31.89
Coal	$110 per short ton	28 MJ/kg	75	5.12
Electricity (resistance heat)	$0.12 per kWh	3.6 MJ/kwh	100	33.33

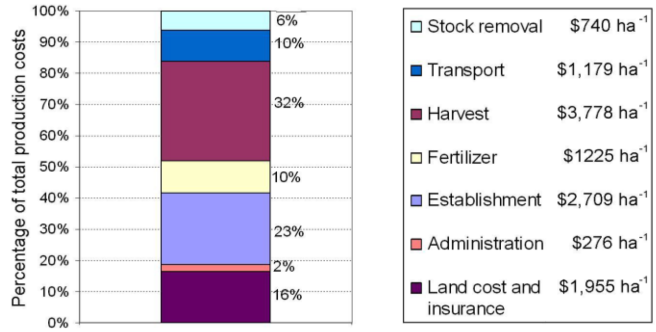
Willow cash flow diagram



(Buchholz and Volk, 2011)

Willow economics

- Yield of 5 odt acre-1 yr-1 (11.3 odt ha-1 yr-1)
- $30/ton delivered
- Has an IRR of 5.3%
- With the following cost structure



Source: Buchholz and Volk 2011

Key factors limiting more use

- Technology (production costs)
  - Logging residues are a less costly biomass source from conventional forests (except for mill residues).
  - cost-effective production with other higher valued forest products (sawlogs, pulping chips)
- Demand (markets)
  - Some market niches for biomass/bioenergy exist
  - No CO_2 market
- Alternative fuel sources (competition)
  - Prices of gas and coal
  - Agricultural crops and crop residues, solar, wind, and hydro energy, among others
  - Other uses of forest resources (pulp markets)

Wood heating systems for institutions

- Typically two to three times the capital costs of oil heating systems
  - complex fuel handling and fuel storage requirements
  - more operation and maintenance (O & M) costs.
- Its all about fuel costs that allows wood heating systems to compete in the marketplace
- It’s a low-cost fuel ($ per million Btu)

Planning and Analysis

- Size of operation
- Amount of energy consumed
- Type of current fuel used
- Engineering assessment and a thorough cost analysis
  - With and without project
  - Budget
  - Cash flow analysis (method used)
  - Assumptions

Life Cycle Analysis

- Most accurate
  - accounts for time value of money
- All project costs and all project benefits are analyzed for each year of the project's entire life
  - Cost of financing
  - Maintenance, repair, and replacement
  - Costs of the competing options
- Assumptions
  - Discount rates
  - Expected fuel price changes
- Sensitivity analysis

Penns valley school example

Total project cost	$,2, 804,694
Cost after grants and subsidies	$1,483,049
Fuel:	61,700 gallons
Fuel Oil Price	$3.50
Wood Chips	1,200 tons
Wood Chip Price	$40.00 /ton
BTU ratio (net basis)	86%
General Inflation	3%
Fuel Oil Inflation	5%
Wood Chip Inflation	3%
Operating and maintenance	$3,000 /year

Other assumptions:

- 30 year life at 4% discount rate
- No repairs
- Payment over 20 years

Financial analysis

Pay Back

	Fuel Oil Cost Only	Wood Chip System	Annual Savings	Capital cost	Simple Payback (yrs)
w/grants	$215,950	$74,513	$141,437	$1,483,049	10.5
w/out grants	$215,950	$74,513	$141,437	$,2, 804,694	19.8

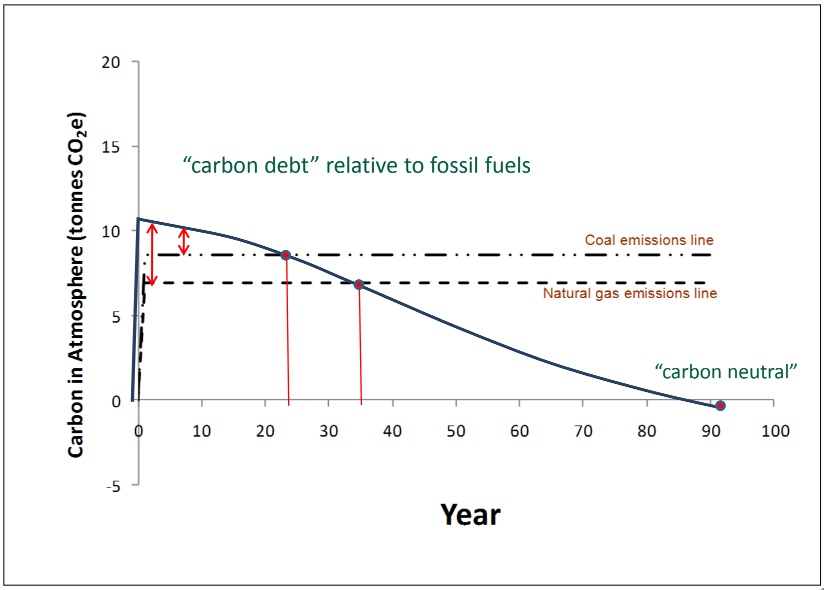
Net present value and rate of return

30 yr NPV	NPV Fuel Oil	NPV Wood Chip Fuel	NPV Cash flow of savings	IRR
4% with grants	-($7,181,104)	-($3,574,099)	$3,607,004	15%
4% without grants	-($7,181,104)	-($4,870,328)	$2,310,776	8%

Other factors to consider

- Storage and supply issues
  - e.g., traffic
- System management issues
  - Repairs
  - Automation
- Tax incentives
  - Depreciation
  - Renewable energy credits
- Environmental benefits or costs
  - Water, nutrients, biodiversity
- Carbon offsets?

‘Debt then dividend’ accounting framework



From Manomet study[13]

Benefits

- For landowners:
  - Revenue from biomass sales and carbon credits
  - Savings on forest management expenses
  - Improve forest health?
  - Reduction in the risk of wildfire and disease/pest outbreaks
- For society:
  - Local jobs and economic development
  - Global warming - positive impact, if sustainable

How Can Biomass Be More Competitive?

- Reduce fuel costs by improving the efficiency in growing, procuring, transporting, and processing forest biomass
- Reduce non-fuel costs through improving efficiency in energy conversion (from biomass to secondary energy)
- Tax CO_2 emissions or provide incentives/credits for carbon displacement